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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 2, 2015

FINAL EXAMINATION	**DURATION**
ENG482 – Engines and Turbomachinery	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

Please read and answer all questions in the examination book.

EXAM CONDITIONS

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

Any hard copy, unannotated dictionary is permitted

Answer on the supplied examination material/s only

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
No additional printed material is permitted	1 x 8 Page Book 1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Answer **ALL** Questions

The Questions should be answered in the Answer Booklet provided.

Marks for each question are indicated.

Total Marks = 100

Question 1 (25 marks)

An SI engine operates on an air-standard cycle four stroke Otto cycle with turbocharging. Air-fuel enters the cylinders at 70 degrees C and 140 kPa, and heat in by combustion q_{in} equals 1800kJ/kg . The compression ratio r_c = 8 and exhaust pressure P_{ex} = 100kPa.

Calculate

1. Temperature at each stage of the cycle in degrees C.
2. Pressure at each stage of the cycle in kPa.
3. Work produced during the expansion stroke (kJ/kg)
4. Work of the compression stroke (kJ/kg)
5. Net pumping work (kJ/kg)
6. Indicated thermal efficiency (%)

Question 2 (10 marks)

Isooctane is burned with air in an engine at an equivalence ratio of 0.8333. Assuming complete combustion, write the balanced chemical reaction equation.

Calculate

1. Air fuel ratio.
2. How much excess air is used (%).
3. AKI and FS of this fuel.

Question 3 (15 marks)

A large twelve cylinder, 460 litre, two stroke cycle engine operates using dual fuel. 92% of the intake air is used for stoichiometric combustion of methanol, while 8% is used for stoichiometric combustion of light diesel fuel for ignition. The engine operates at 195 RPM with a volumetric efficiency of 93%. The methanol is input during the intake stroke, while diesel fuel is injected into each cylinder by a single injector from 15^0 bTDC to 6^0 aTDC.

Calculate;

1. Mass flow of air into the engine (kg/sec).
2. Mass flow rate of methanol into the engine (kg/sec).
3. Mas flow rate of diesel through one injector (kg/sec).

Question 4 (10 marks)

A two litre, four cylinder, open chamber SI engine operates at 3500 RPM using stoichiometric gasoline. At this speed, volumetric efficiency is 93% , combustion efficiency is 98%, indicated thermal efficiency is 47%, and mechanical efficiency is 86%

Calculate :

1. Brake power in kW
2. bmep in kPa
3. Amount of unburned fuel exhausted from the engine in kg/hr.
4. bsfc in gm/kwhr.

Question 5 (10 marks)

A large CI engine operating at 310 RPM has open combustion chambers and direct injection, with 260mm bores, a 730mm stroke and a compression ratio of 16.5:1. Fuel injection in each cylinder starts at 21^0 bTDC and lasts for 0.019 sec. ID is 0.0065 sec.

Calculate :

1. ID in degrees of engine rotation.
2. Crank angle position when combustion starts.
3. Crank angle position when injection stops.

Question 6 (10 marks)

A flat 6 SI engine has a capacity of 1500cc, 4 valves per cylinder, single overhead camshaft per bank and a compression ratio of 9:1. The engine currently uses 95RON gasoline which is directly injected into each cylinder on a four stroke cycle. If all other conditions are kept the same this engine is proposed to be fitted with twin spark plugs per cylinder. If all other engine parameters are kept the same, list and discuss three advantages and three disadvantages, this change gives for modern engines.

Question 7 (5 marks)

A five cylinder SI engine with bore B= 85.6mm and stroke S=0.92B, operates at 2800 RPM on an air-standard Otto cycle. During the compression stroke, the air in each cylinder is rotating at an angular velocity of 250 revs per second, using the paddlewheel model. At TDC, the gas mixture into a clearance volume that can be approximated as a 50mm diameter cylindrical bowl in the face of the piston.

Calculate

1. The swirl ratio during the compression stroke using two different equations
2. The angular velocity in the bowl at TDC, assuming angular momentum is conserved.

Question 8 **(15 marks)**

A centrifugal compressor has the following properties.

Double sided impeller

Mass flow = 14.23 kg/s

N = 22050 rpm

Tip diameter = 530 mm

Number of blades = 28

Power input factor = 1.03

Radial compressor efficiency = 78%.

Use C_p = 1.005 kJ/kg-K, T_{01} = 293 K, P_{01} = 1.1 bar

1. Determine the slip factor.
2. Determine the temperature rise across the compressor.
3. Determine the pressure rise across the impeller.

Formula Sheet

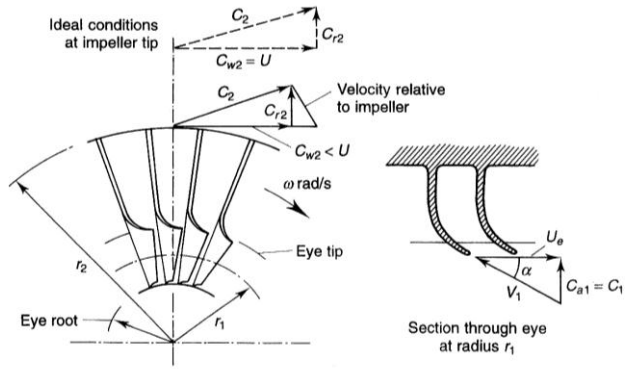

FIG. 4.2 Nomenclature

$$\sigma = \frac{C_{W2}}{U}$$

$$\sigma = 1 - \frac{0.63\pi}{n} = 1 - \frac{1.98}{n}$$

$$T = C_{W2} r_2$$

$$W = \sigma U^2$$

$$W = \psi \sigma U^2$$

$$\frac{P_{03}}{P_{01}} = \left(1 + \frac{\eta_c (T_{03} - T_{01})}{T_{01}}\right)^{\frac{\gamma}{(\gamma-1)}}$$

$$T_{03} - T_{01} = \frac{\psi \sigma U^2}{C_p}$$

$$\dot{W} = m c_p (T_{03} - T_{01})$$

$$U = \pi d N$$

$$PLF = \frac{\Delta p_o}{\frac{m^2}{2\rho_1 A_m^2}} = K_1 + K_2\left(\frac{T_{02}}{T_{01}} - 1\right) \qquad \rho_1 = \frac{P}{RT}$$

where

Δp_o = pressure drop across combustor
m = air mass flow
ρ_1 = density of air at inlet
A_m = maximum cross sectional area of combustor
K_1 & K_2 = constants